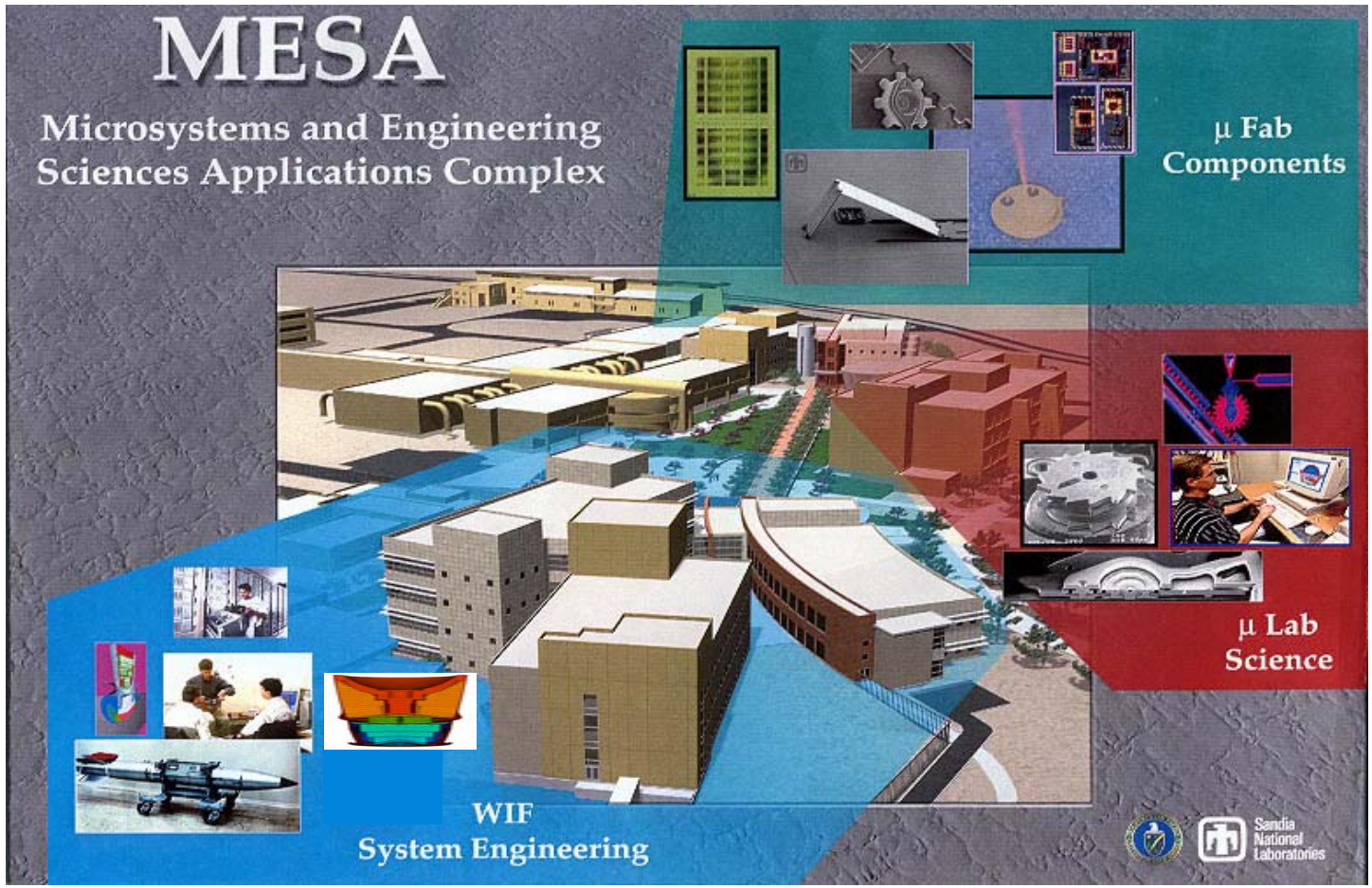
MESA: A Government / University / Industry Partnership Opportunity for Microsystems



Sandia is a Multiprogram Laboratory Operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy Under Contract DE-ACO4-94AL85000.

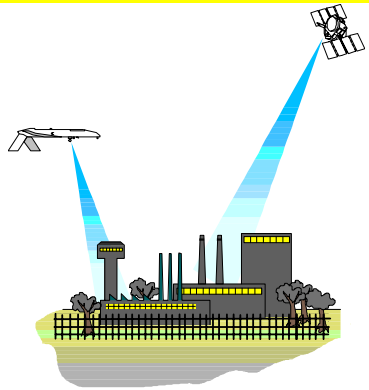
Regan Stinnett, MESA Institute
Sandia National Laboratories
June 29, 2003

Sandia is a National Security Laboratory

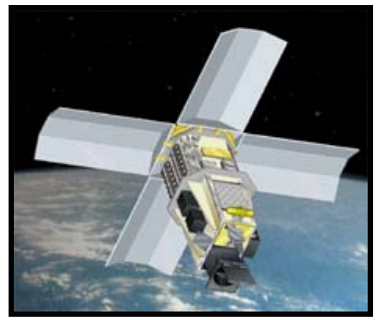
Nuclear Weapons

Safe, Secure,
Reliable Weapons

Nonproliferation & Materials Control



Detection



Surveillance

Energy & Critical Resources

Energy

Information

Transportation

Architectural
Surety

Military Technologies & Applications

DHS

Physical Security

Force/Facility
Protection

Urban Operations

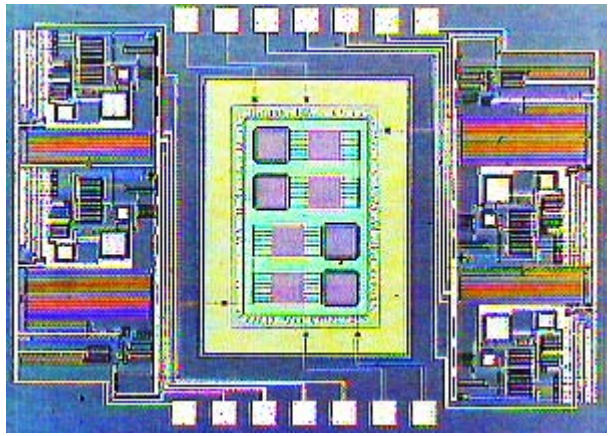
Military and anti- terrorism
technologies

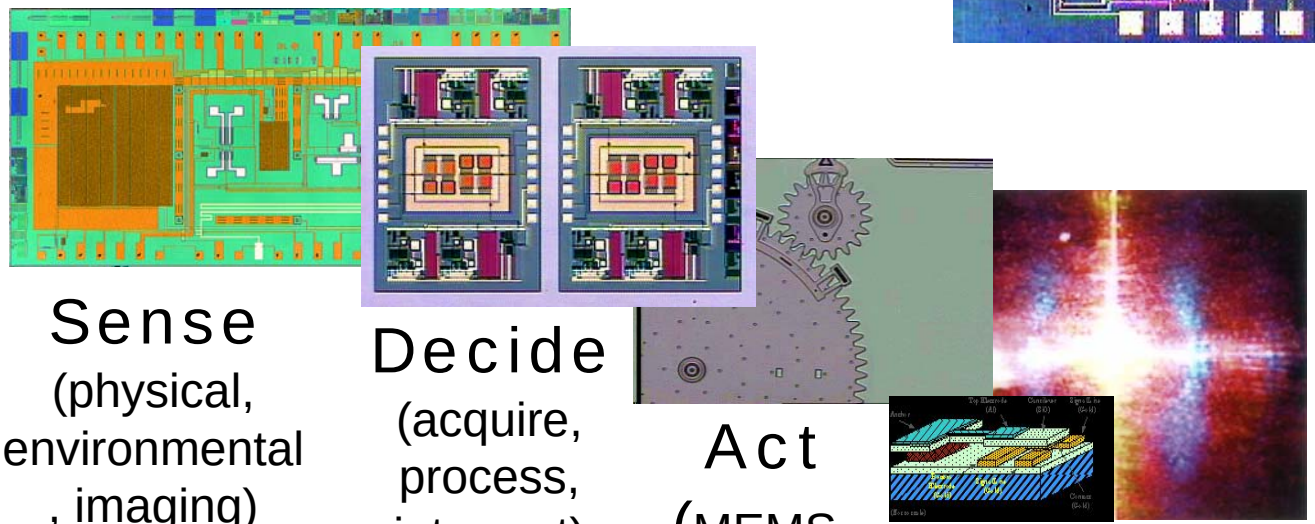
Microsystems Technologies will be key in each of these areas

Sandia National Laboratories

Integrated Microsystems: The Next Technology Revolution

- **The next leap in function of Integrated Circuits will involve more than just packing more transistors on the chip**
- **It will involve combining Si, III-V, MEMS, and advanced packaging technologies to create an integrated capability to :**





Sense
(physical, environmental, imaging)

Decide
(acquire, process, interpret)

Act
(MEMS, microfluidics)

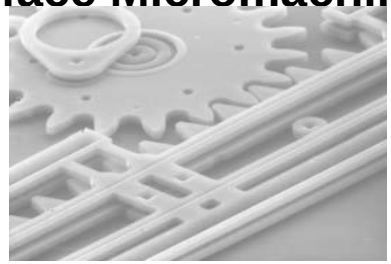
Communicate
(optical, RF)

… affordably and reliably.

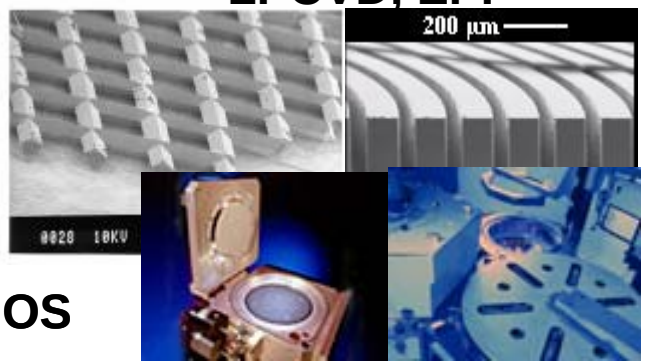
Sandia National Laboratories

Producing integrated microsystems requires a broad spectrum of capabilities

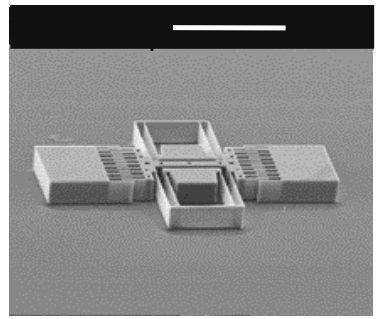
Polysilicon Surface Micromachining



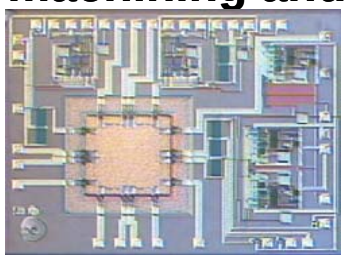
Wet Chemistry Bulk Silicon Etching LPCVD, EPI



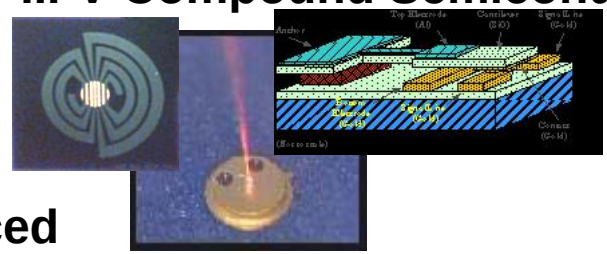
High Aspect Ratio Silicon Etching (HARSE)



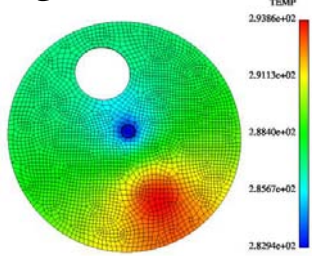
Integrated Surface Micromachining and CMOS



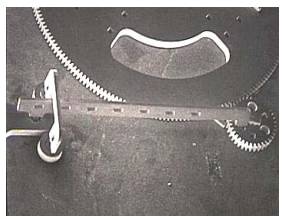
III-V Compound Semiconductors



Qualification



LIGA



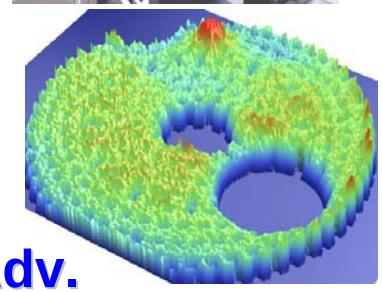
Advanced Packaging

It is very difficult to obtain these capabilities *plus* the flexibility for R&D and prototyping.

Sandia National Laboratories

MESA provides complete facilities for microsystems design, integration, fabrication and testing

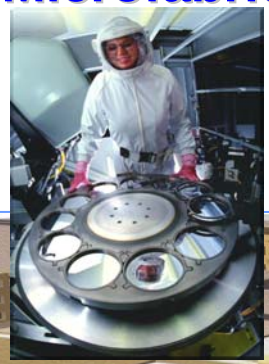
$463M including > 50% equipment and cleanrooms

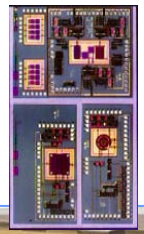


Adv. computation

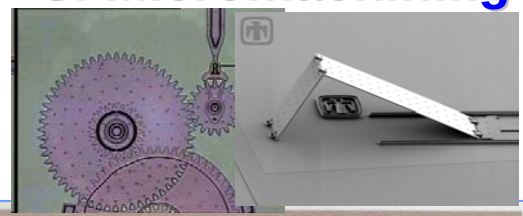
Packaging and qualification

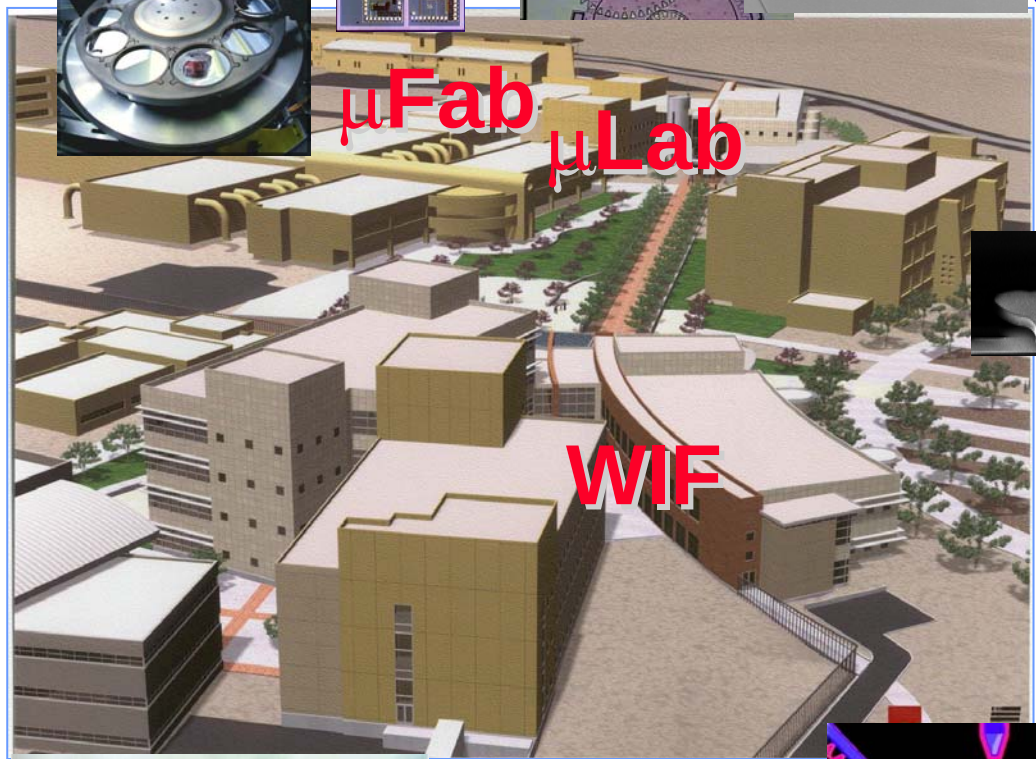
Microfabrication





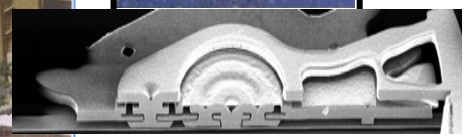
Si Micromachining





Photonics

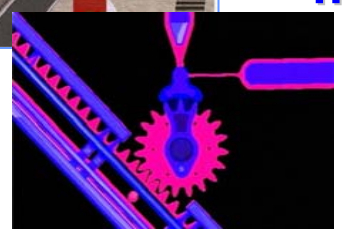
III-V Semiconductors



Nanotechnology

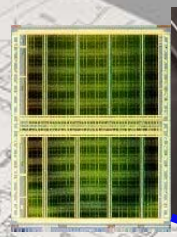
3-D design, mod/sim

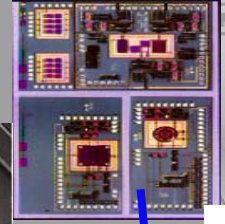
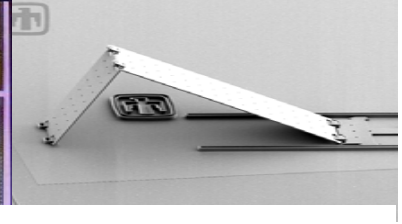
648 people
391,000 sq ft



Mesa Complex

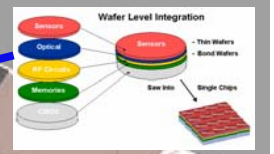
Components



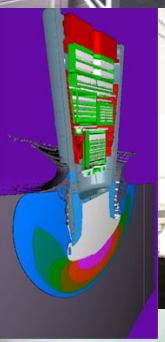



98,000 GSF

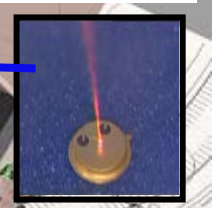
Packaging



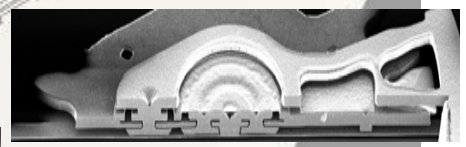
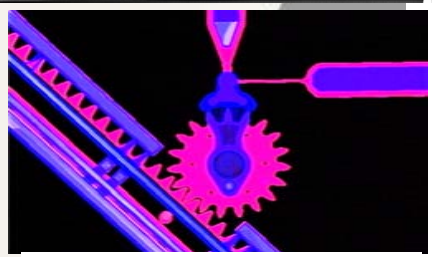
System Engineering

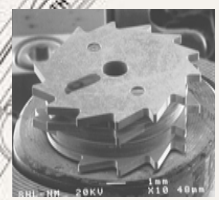
374 people
162,000 GSF



Science

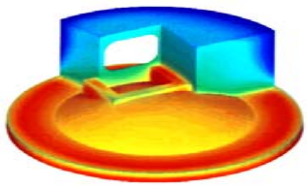



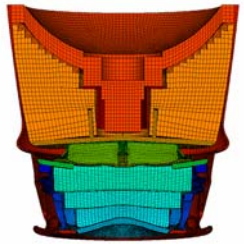
274 people
131,000 GSF



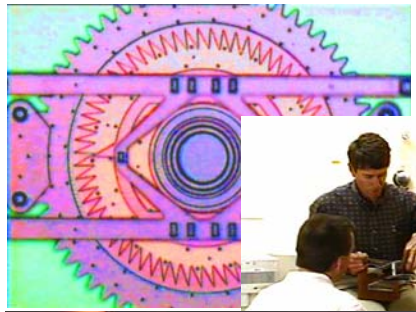
TOTALS: Construction: $246M, Equipment: $168M
Contingency: $49M, TEC: $463M

Sandia's computing resources are key elements of MESA





JCEL - Algorithm & Code Development



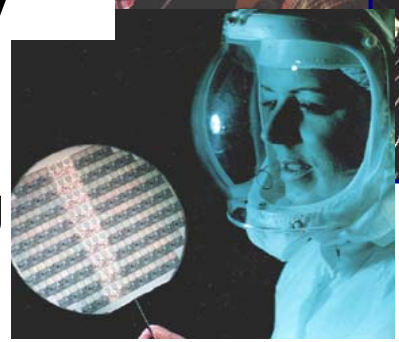
Microsystems & components R&D

High resolution 3-D visualization

Engineering & Analysis,

Virtual Prototyping

10 Gb/sec Desktop Connectivity



Production Computing
3 T-ops ⟶ 20T-ops

Microsystems Process R&D

Sandia National Laboratories

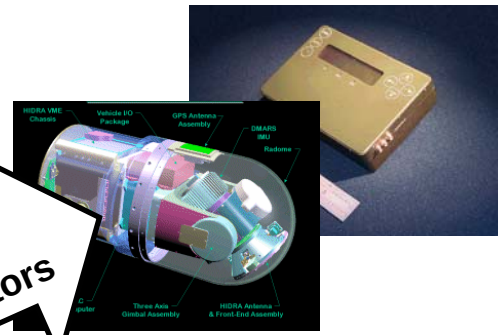
Sandia Is Using MESA To Advance Microsystems Technologies Through Flagship Products

Microprocessors and Computers

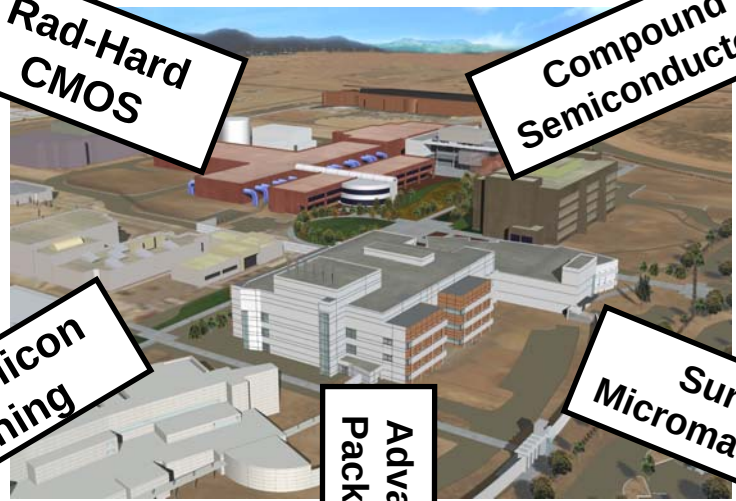
MESA

Rad-Hard CMOS

Compound Semiconductors



Synthetic Aperture Radar and RF Tags



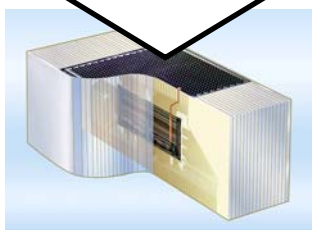
Handheld Chemical-Agent Detectors

Bulk Silicon Etching

Advanced Packaging

Surface Micromachining

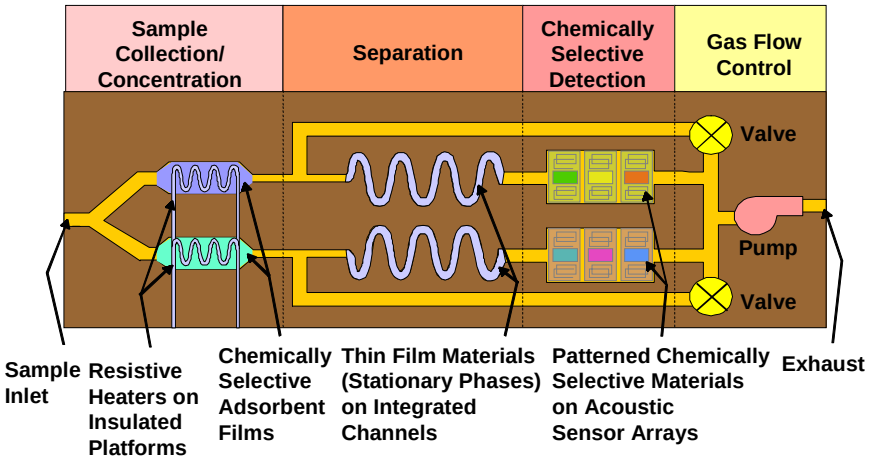
Mechanical Switches, Sensors, Actuators

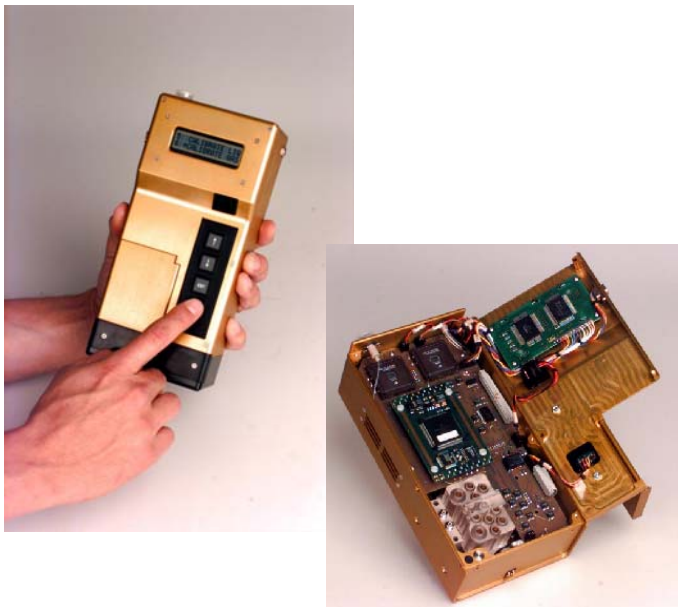


Optical Sensor Array

Sandia National Laboratories

µChemLab™
Handheld Chemical Analysis System





- µChemLab system includes on-chip gas chromatograph with preconcentrator, separator column, and detectors
- Micromachined components enable miniaturization and rapid, low power response
- System has been assembled into a user-friendly hand-held unit

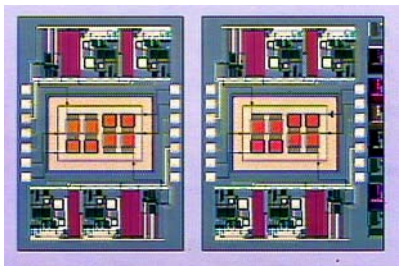
Applications:

- CW and BW agent detection
- Explosive detection
- Environmental monitoring

Sandia National Laboratories

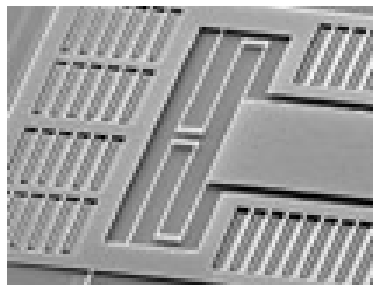
But …making Integrated Microsystems is difficult: e.g. MEMS

Class I
No Moving parts



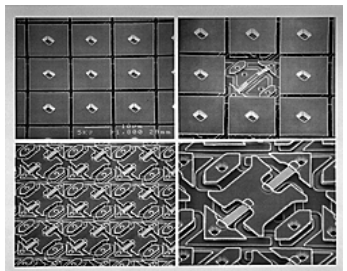
Accelerometers
Pressure Sensors
Ink Jet Print Heads
Strain Gauge

Class II
Moving Parts, No Rubbing or Impacting Surfaces



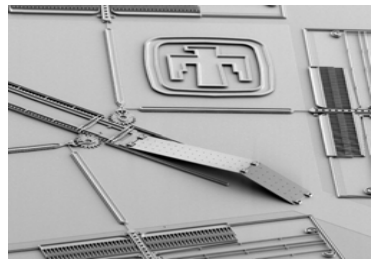
Gyros
Comb Drives
Resonators
Filters

Class III
Moving Parts, Impacting Surfaces



TI DMD
Relays
Valves
Pumps

Class IV
Moving Parts, Impacting and Rubbing Surfaces



Optical Switches
Corner Cube Refl.
Shutters
Scanners
Locks
Discriminators

(Successful Commercial Products in Blue)

Sandia needs strong partners to help us create more complex, integrated, and reliable devices

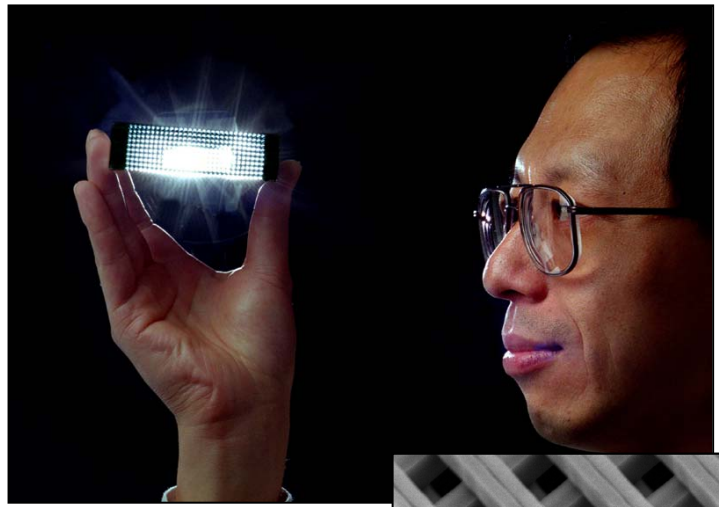
Sandia National Laboratories

Partnerships are vital to our work

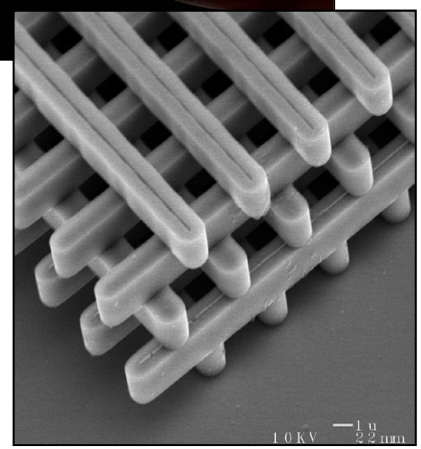
$100 million annually in industry partnerships

Includes:

Intel, Applied Materials, Fairchild, Motorola, EMCOR, MEMX …



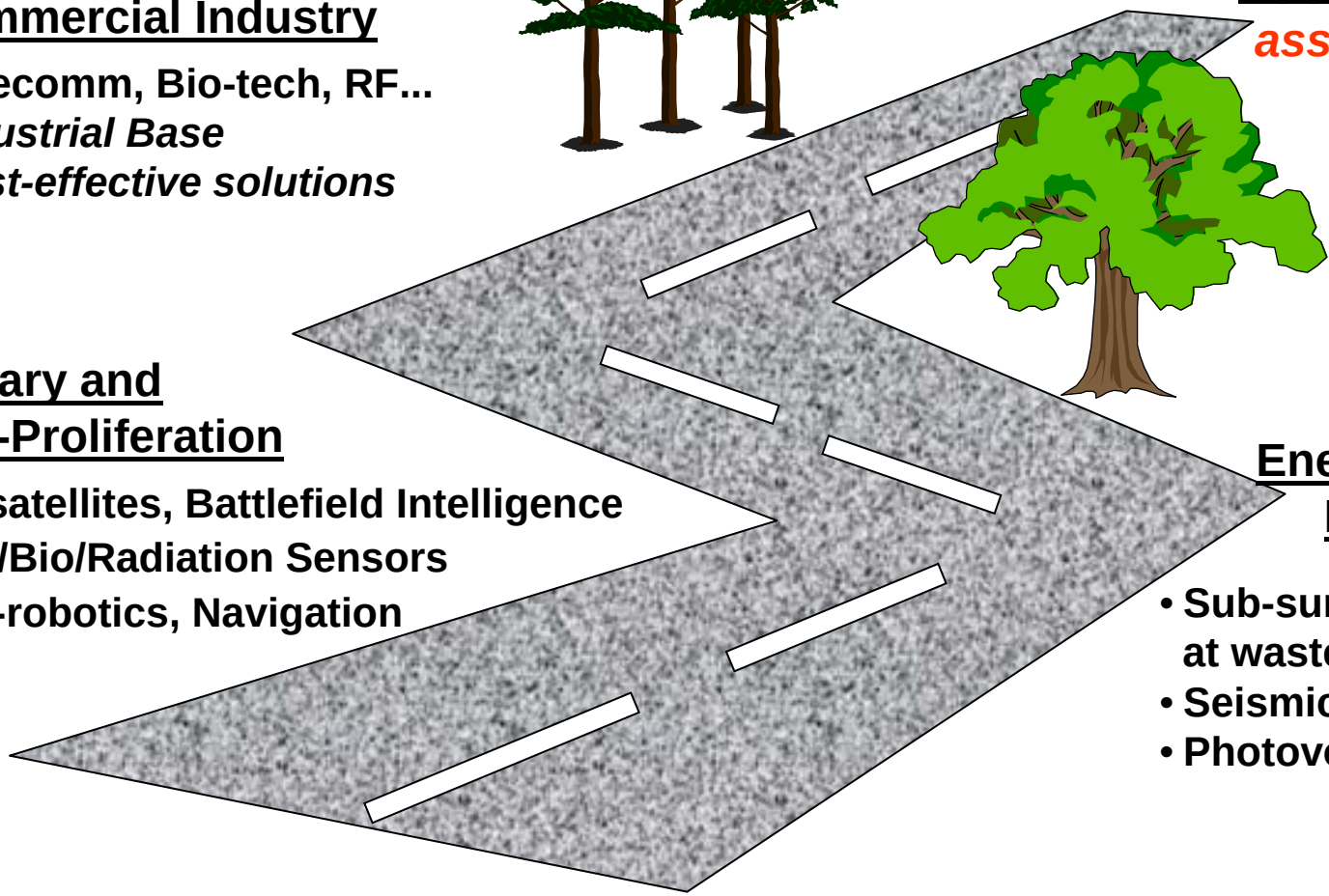
More than 500 research projects with universities



Sandia has executed 516 CRADAs with industry partners in 42 states … and 652 commercial licenses

Sandia National Laboratories

Road to Deploy Microsystems in Weapons Goes Through Other Applications, Industry, & Universities



Weapons Applications

assured reliability

Commercial Industry

- Telecomm, Bio-tech, RF...
- *Industrial Base*
- *Cost-effective solutions*

Military and Non-Proliferation

- Nanosatellites, Battlefield Intelligence
- Chem/Bio/Radiation Sensors
- Micro-robotics, Navigation

Energy & Critical Resources

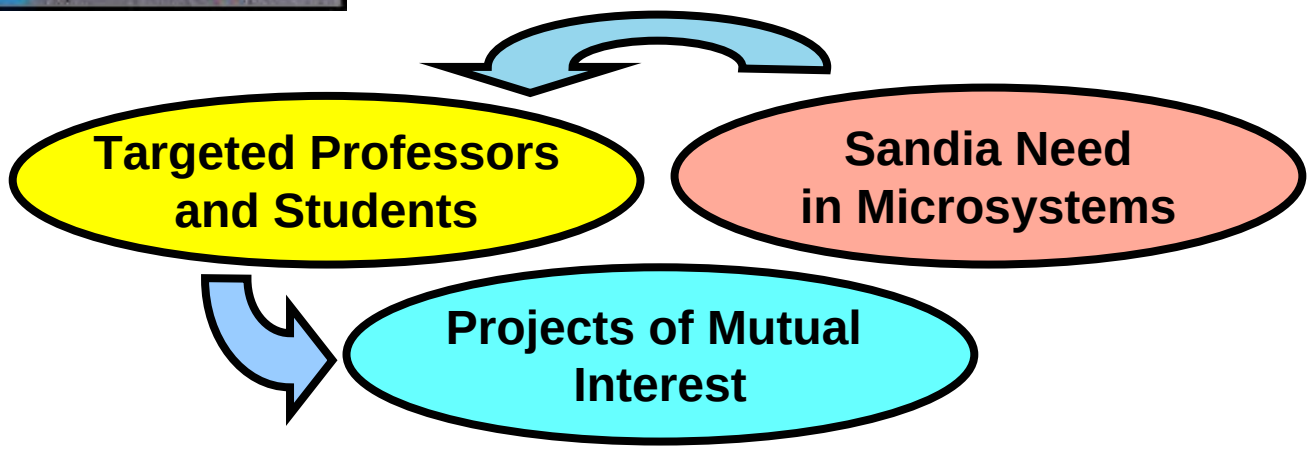
- Sub-surface monitoring at waste sites
- Seismic Sensors/oil expl.
- Photovoltaics, ...

University participation to create the talent pool and new ideas

The MESA Institute: Microsystems Partnerships with Universities

<u>Mission:</u> Develop key microsystems technologies while training top students on-site at Sandia's MESA facilities

<u>Approach:</u>



Sandia National Laboratories

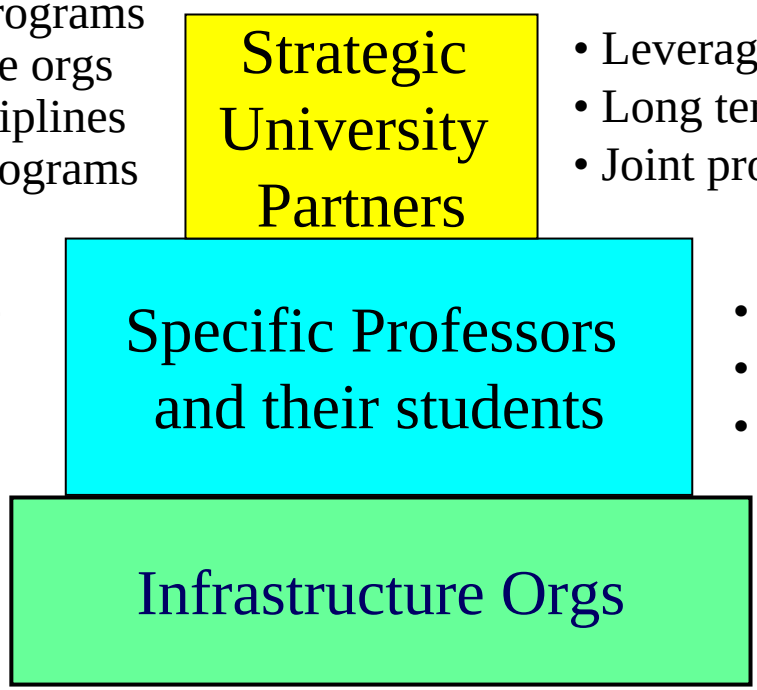
Students and Professors will Benefit from Participation

- **Access to personnel, instruments, facilities, and capabilities not otherwise available**
  - **Commercial facilities don't provide research flexibility**
  - **University facilities rarely have the full range of capabilities**
- **Access to on-site research opportunities for students and professors, with costs paid by Sandia**
- **Exposure to "industry-like" microsystems environments**
- **Educational and employment opportunities for undergrad, graduate and postdoctoral students**
- **Joint proposals enabled by Sandia capabilities**

The MESA Institute Program Has Three Tiers

Characteristics

Goals



Strategic University Partners
- Broad match to Sandia programs
- Interest from multiple line orgs and multiple faculty/disciplines
- Collaboration for joint programs

- Leverage Sandia & Univ programs
- Long term pipeline for new hires
- Joint programs w/ 3rd party funding

University Partners
- Specific faculty expertise needed by line orgs
- Top graduate students
- Microsystems courses

- Leverage line org program
- Top new hires in key areas
- Long term faculty relations

Educational Infrastructure
- Tech/Voc Inst.
- Faculty training

- Technologist availability
- Long term tech pipeline

Each type of partnership is important to Sandia!

Sandia National Laboratories

To Maximize the Benefit of MESA to the Nation Sandia Needs Long Term Partners

Partners should be:

- Working in microtechnology / nano-science areas of interest to Sandia
- Have interdisciplinary microsystems programs of national stature
- Committed to significant investment in their own microsystems programs
- Willing to give Sandia interests high priority

Sandia offers its partners:

- Long term collaborative relationships with Sandia organizations
- Access to Sandia's world class facilities
- Fellowships for top students, and professors in microsystems and related nano science areas to work on-site at Sandia
- Support for joint proposals to federal agencies (eg. DOE, NSF, NIH,...)

Sandia National Laboratories

MESA Institute Process - Overview

- Process initiated by Sandia staff, professor and student
- Graduate and undergraduate students (U.S. citizens)
- Negotiated on-site assignments of 2 to 24 months
  - Participating professor provides research guidance
  - Designated Sandia staff provides on-site supervision/mentoring
- Microsystems projects of mutual interest to Sandia, professor, and student
  - 3 page proposals reviewed by MESA Institute panel within 6 weeks
  - MESA Institute funds student labor, travel, plus professor visits
  - Sandia provides facilities, work space, processing

Sandia Points of Contact

General Information
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RF and Opto Microsystems
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Microsensors
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MESA Institute Web Page: http://mesa.sandia.gov/institute/institute.htm

Sandia National Laboratories

Summary: MESA Is Creating …

- Advanced facilities and capabilities to meet national needs for microsystems R&D, design, and prototyping
- Co-located multi-disciplinary teams
  - Microsystems (microelectronics, MEMS, III-V, packaging)
  - Computation and simulation
  - Materials science
  - Systems design and integration
  - including government, academic, and industrial partners
- Opportunities for students and professors to participate in leading edge microsystems research in areas of national interest
- Opportunities for government and industry partnerships to take technology from R&D to use in national security applications
- Value Proposition for Partners
  - access unique microsystems R&D and prototyping facilities through collaboration with Sandia organizations on joint projects of mutual interest
  - cost of work is leveraged by $1B investment in capital facilities and capabilities

MESA Needs You Too!

U. Michigan
UC Berkeley
U. Oklahoma
U. Colorado
Georgia Tech
AF Inst. Of T

Arizona State
U. Florida
U. Wisconsin
U. Missouri-R
U. New Mexico
Rochester Inst. T.
Florida State U.

Purdue U.
U. Arizona
Texas Tech
NJ Inst.Tech.
Univ. of Pacific
Texas A&M

UCLA
NM State U.
U. Arkansas
U. Minnesota
Kettering Inst
U. Of Illinois
MIT

41 students from 26 universities, to 20 Sandia orgs in FY03

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